

## DIGITAL TV TUNER IC

### FEATURES

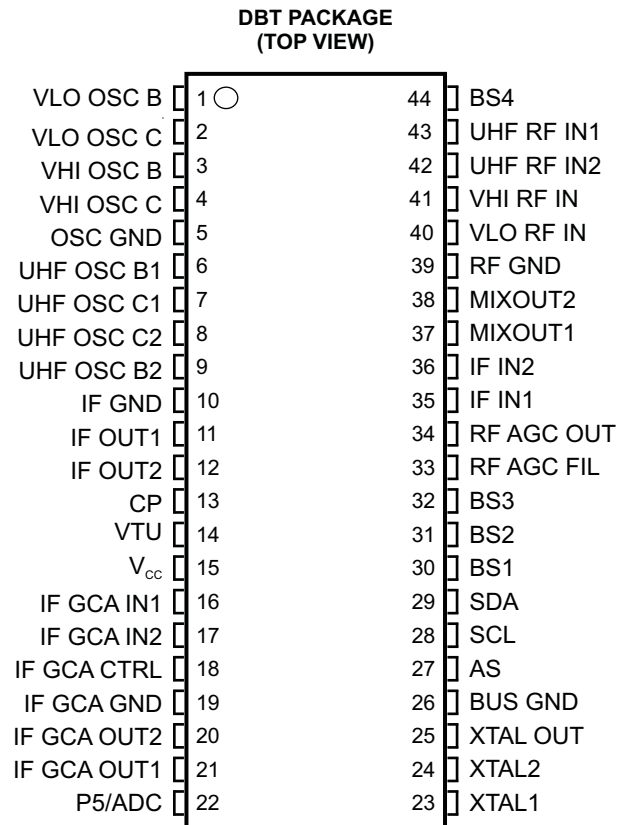
- Integrated Mixer/Oscillator/PLL and IF GCA
- VHF-L, VHF-H, UHF 3-Band Local Oscillator
- RF AGC Detector Circuit
- External 4-Pin IF Filter Between Mixer Output and IF Amplifier Input
- I<sup>2</sup>C Bus Protocol Bidirectional Data Transmission
- High-Voltage Tuning Voltage Output
- Four NPN-Type Band-Switch Drivers
- One Auxiliary Port/5-Level ADC
- Crystal Oscillator Output
- Programmable Reference Divider Ratio (24/28/50/64/80/128)
- Low Distortion IF Gain Controlled Amplifier
- Standby Mode
- 5-V Power Supply
- 44-Pin Thin Shrink Small-Outline Package (TSSOP)

### APPLICATIONS

- Digital TVs
- Digital CATVs
- Set-Top Boxes

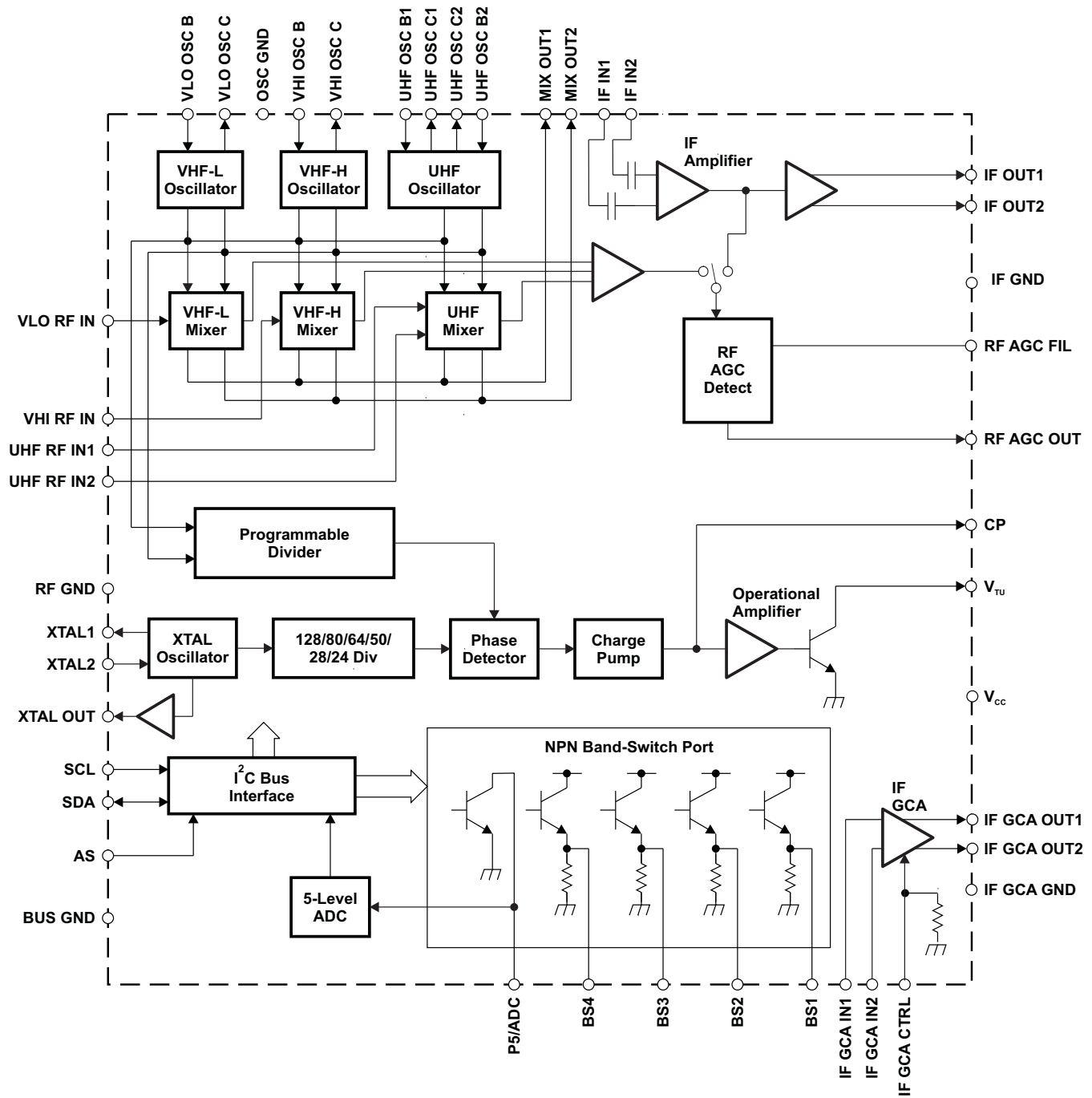
### DESCRIPTION

The SN761668 is a low-phase-noise synthesized tuner IC designed for digital TV tuning systems. The circuit consists of a PLL synthesizer, three-band local oscillator and mixer, RF AGC detector circuit, and IF gain-controlled amplifier. The SN761668 is available in a small-outline package.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

### FUNCTIONAL BLOCK DIAGRAM



## TERMINAL FUNCTIONS

TERMINAL NAME	NO.	DESCRIPTION	SCHEMATIC
AS	27	Address selection input	<a href="#">Figure 1</a>
BS1	30	Band-switch 1 output	<a href="#">Figure 2</a>
BS2	31	Band-switch 2 output	<a href="#">Figure 2</a>
BS3	32	Band-switch 3 output	<a href="#">Figure 2</a>
BS4	44	Band-switch 4 output	<a href="#">Figure 2</a>
BUS GND	26	BUS ground	
CP	13	Charge-pump output	<a href="#">Figure 3</a>
IF GCA CTRL	18	IF GCA CTRL voltage inout	<a href="#">Figure 4</a>
IF GCA GND	19	IF GCA ground	
IF GCA IN1	16	IF GCA input 1	<a href="#">Figure 5</a>
IF GCA IN2	17	IF GCA input 2	<a href="#">Figure 5</a>
IF GCA OUT1	21	IF GCA output 1	<a href="#">Figure 6</a>
IF GCA OUT2	20	IF GCA output 2	<a href="#">Figure 6</a>
IF GND	10	IF ground	
IF IN1	35	IF amplifier input 1	<a href="#">Figure 7</a>
IF IN2	36	IF amplifier input 2	<a href="#">Figure 7</a>
IF OUT1	11	IF amplifier output 1	<a href="#">Figure 8</a>
IF OUT2	12	IF amplifier output 2	<a href="#">Figure 8</a>
MIXOUT1	37	Mixer output 1	<a href="#">Figure 9</a>
MIXOUT2	38	Mixer output 2	<a href="#">Figure 9</a>
OSC GND	5	Oscillator ground	
P5/ADC	22	Port-5 output/ADC input	<a href="#">Figure 10</a>
RF AGC FIL	33	RF AGC additional capacitor pin	<a href="#">Figure 11</a>
RF AGC OUT	34	RF AGC output	<a href="#">Figure 12</a>
RF GND	39	RF ground	
SCL	28	Serial clock input	<a href="#">Figure 13</a>
SDA	29	Serial data input/output	<a href="#">Figure 14</a>
UHF OSC B1	6	UHF oscillator base 1	<a href="#">Figure 15</a>
UHF OSC B2	9	UHF oscillator base 2	<a href="#">Figure 15</a>
UHF OSC C1	7	UHF oscillator collector 1	<a href="#">Figure 15</a>
UHF OSC C2	8	UHF oscillator collector 2	<a href="#">Figure 15</a>
UHF RF IN1	43	UHF RF input 1	<a href="#">Figure 16</a>
UHF RF IN2	42	UHF RF input 2	<a href="#">Figure 16</a>
V <sub>CC</sub>	15	Supply voltage for mixer/oscillator/PLL: 5 V	
VHI OSC B	3	VHF-H oscillator base	<a href="#">Figure 17</a>
VHI OSC C	4	VHF-H oscillator collector	<a href="#">Figure 17</a>
VHI RF IN	41	VHF-H RF input	<a href="#">Figure 18</a>
VLO OSC B	1	VHF-L oscillator base	<a href="#">Figure 19</a>
VLO OSC C	2	VHF-L oscillator collector	<a href="#">Figure 19</a>
VLO RF IN	40	VHF-L RF input	<a href="#">Figure 20</a>
VTU	14	Tuning voltage amplifier output	<a href="#">Figure 3</a>
XTAL1	23	4-MHz crystal oscillator output	<a href="#">Figure 21</a>
XTAL2	24	4-MHz crystal oscillator input	<a href="#">Figure 21</a>
XTALOUT	25	4-MHz crystal oscillator output	<a href="#">Figure 22</a>

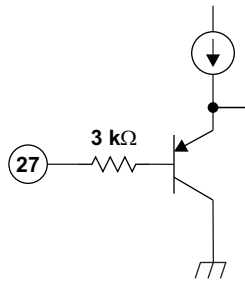


Figure 1. AS

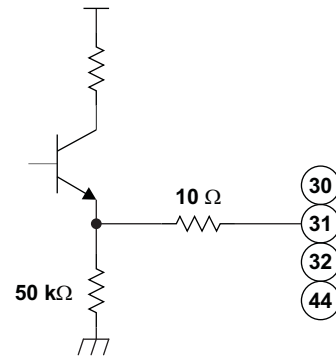


Figure 2. BS1, BS2, BS3, and BS4

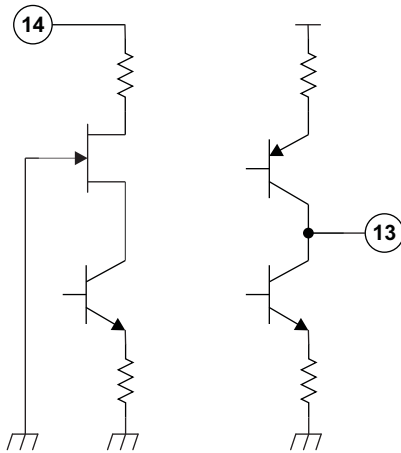


Figure 3. CP and VTU

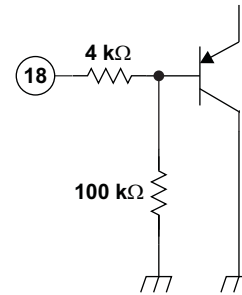


Figure 4. IF GCA CTRL

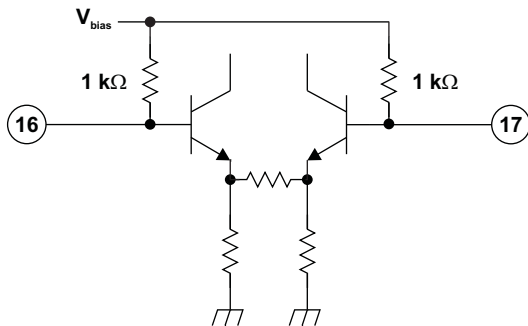


Figure 5. IF GCA IN1 and IF GCA IN2

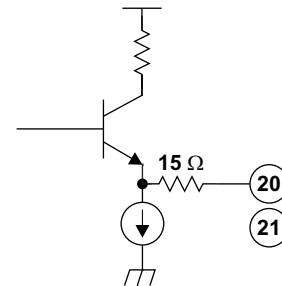


Figure 6. IF GCA OUT1 and IF GCA OUT2

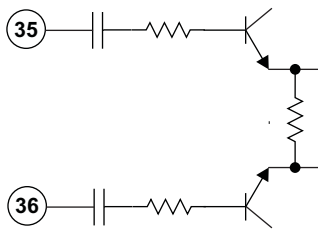


Figure 7. IF IN1 and IF IN2

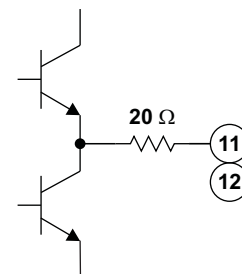


Figure 8. IF OUT1 and IF OUT2

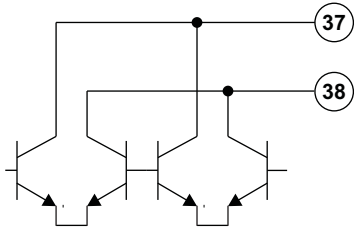


Figure 9. MIXOUT1 and MIXOUT2

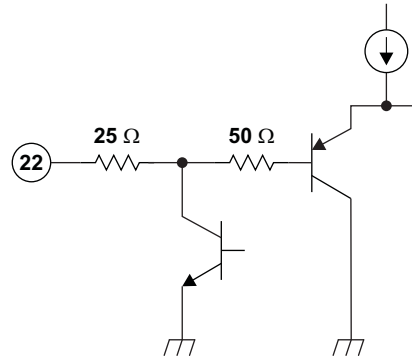


Figure 10. P5/ADC

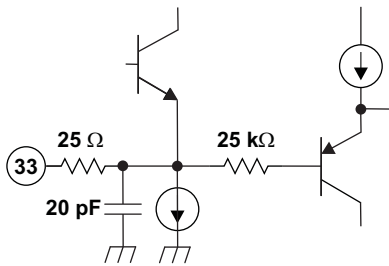


Figure 11. RF AGC FIL

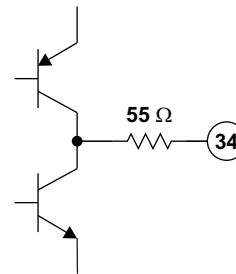


Figure 12. RF AGC OUT

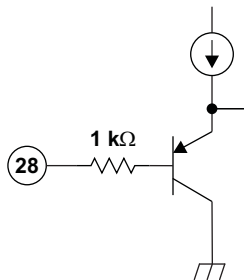


Figure 13. SCL

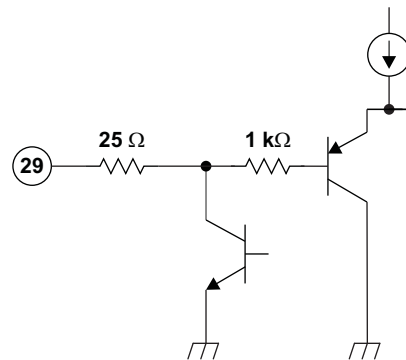


Figure 14. SDA

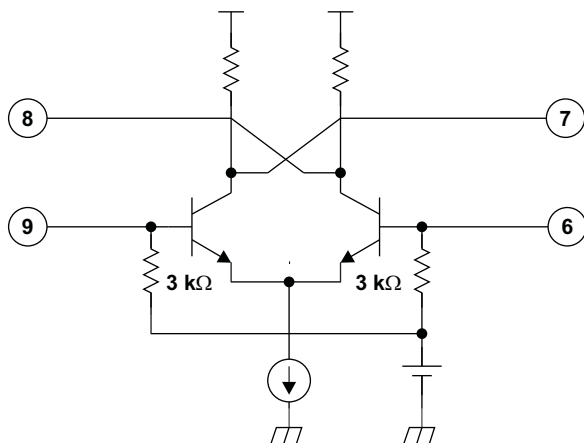


Figure 15. UHF OSC B1, UHF OSC B2, UHF OSC C1, and UHF OSC C2

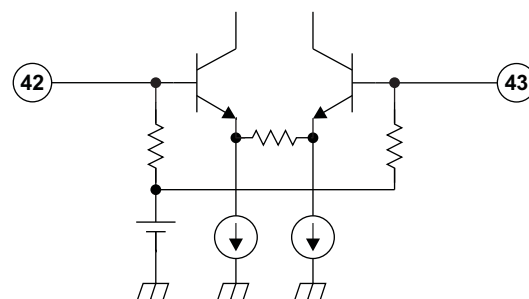


Figure 16. UHF RF IN1 and UHF RF IN2

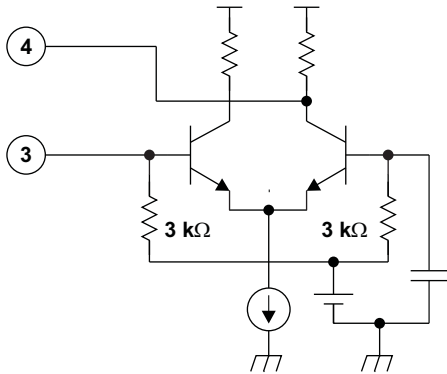


Figure 17. VHI OSC B and VHI OSC C

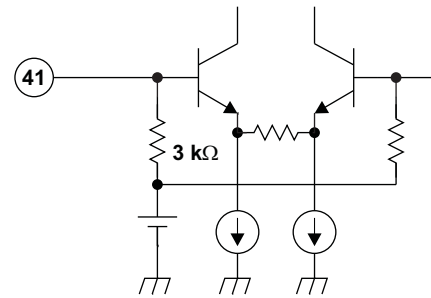


Figure 18. VHI RF IN

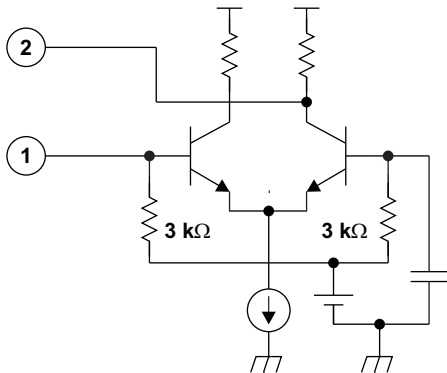


Figure 19. VLO OSC B and VLO OSC C

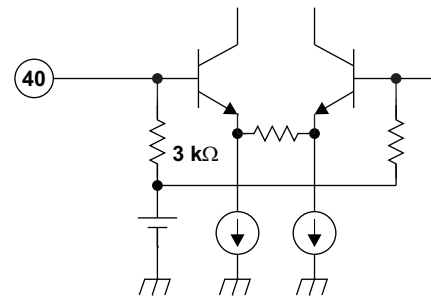


Figure 20. VLO RF IN

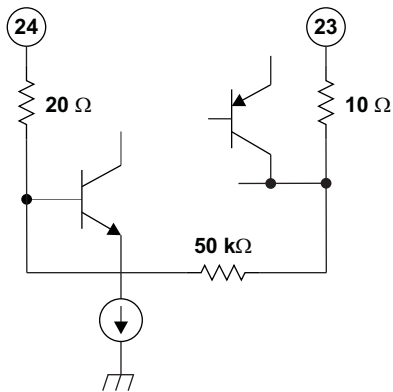


Figure 21. XTAL1 and XTAL2

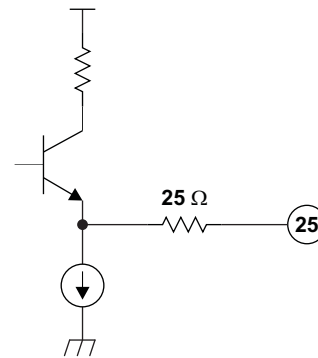


Figure 22. XTALOUT

## ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>

over recommended operating free-air temperature range (unless otherwise noted)

			MIN	MAX	UNIT
V <sub>CC</sub>	Supply voltage range <sup>(2)</sup>	V <sub>CC</sub>	–0.4	6.5	V
V <sub>GND</sub>	Input voltage range 1 <sup>(2)</sup>	RF GND, OSC GND	–0.4	0.4	V
VTU	Input voltage range 2 <sup>(2)</sup>	VTU	–0.4	35	V
V <sub>IN</sub>	Input voltage range 3 <sup>(2)</sup>	Other pins	–0.4	6.5	V
P <sub>D</sub>	Continuous total dissipation <sup>(3)</sup>	T <sub>A</sub> ≤ 25°C		1438	mW
T <sub>A</sub>	Operating free-air temperature range		–20	85	°C
T <sub>stg</sub>	Storage temperature range		–65	150	°C
T <sub>J</sub>	Maximum junction temperature			150	°C
t <sub>SC(max)</sub>	Maximum short-circuit time	Each pin to V <sub>CC</sub> or to GND		10	s

- (1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) Voltage values are with respect to the IF GND of the circuit.
- (3) Derating factor is 11.5 mW/°C for T<sub>A</sub> ≥ 25°C.

## RECOMMENDED OPERATING CONDITIONS

			MIN	NOM	MAX	UNIT
V <sub>CC</sub>	Supply voltage		4.5	5	5.5	V
VTU	Tuning supply voltage			30	33	V
I <sub>BS</sub>	Output current of band switch	BS1 – BS4, one band switch on			10	mA
I <sub>P5</sub>	Output current of port 5	P5/ADC			–5	mA
T <sub>A</sub>	Operating free-air temperature		–20		85	°C



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

IF IN1, IF IN2, MIXOUT1, and MIXOUT2 (pins 35–38) withstand 1.5 kV, and all other pins withstand 2 kV, according to the Human-Body Model (1.5 kΩ, 100 pF).

## ELECTRICAL CHARACTERISTICS

### Total Device and Serial Interface

$V_{CC} = 4.5\text{ V to }5.5\text{ V}$ ,  $T_A = -20^\circ\text{C to }85^\circ\text{C}$  (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$I_{CC1}$	Supply current 1			115	140	mA
$I_{CC2}$	Supply current 2	One band switch on ( $I_{BS} = 10\text{ mA}$ )		125	150	mA
$I_{CC-STBY}$	Standby supply current	STBY = 1		9		mA
$V_{IH}$	High-level input voltage (SCL, SDA)		2.5			V
$V_{IL}$	Low-level input voltage (SCL, SDA)				1.35	V
$I_{IH}$	High-level input current (SCL, SDA)				10	$\mu\text{A}$
$I_{IL}$	Low-level input current (SCL, SDA)		-10			$\mu\text{A}$
$V_{POR}$	Power-on-reset supply voltage (threshold of supply voltage between reset and operation mode)		2.1	2.8	3.5	V
<b>I<sup>2</sup>C Interface</b>						
$V_{ASH}$	Address-select high-input voltage (AS)	$V_{CC} = 5\text{ V}$	4.5		5	V
$V_{ASM1}$	Address-select mid-input 1 voltage (AS)	$V_{CC} = 5\text{ V}$	2		3	V
$V_{ASM2}$	Address-select mid-input 2 voltage (AS)	$V_{CC} = 5\text{ V}$	1		1.5	V
$V_{ASL}$	Address-select low-input voltage (AS)	$V_{CC} = 5\text{ V}$			0.5	V
$I_{ASH}$	Address-select high-input current (AS)				50	$\mu\text{A}$
$I_{ASL}$	Address-select low-input current (AS)		-10			$\mu\text{A}$
$V_{ADC}$	ADC input voltage	See <a href="#">Table 10</a>	0		$V_{CC}$	V
$I_{ADH}$	ADC high-level input current	$V_{ADC} = V_{CC}$			10	$\mu\text{A}$
$I_{ADL}$	ADC low-level input current	$V_{ADC} = 0\text{ V}$	-10			$\mu\text{A}$
$V_{OL}$	Low-level output voltage (SDA)	$V_{CC} = 5\text{ V}$ , $I_{OL} = 3\text{ mA}$			0.4	V
$I_{SDAH}$	High-level output leakage current (SDA)	$V_{SDA} = 5.5\text{ V}$			10	$\mu\text{A}$
$f_{SCL}$	Clock frequency (SCL)			100	400	kHz
$t_{HD-DAT}$	Data hold time	See <a href="#">Figure 23</a>	0		0.9	$\mu\text{s}$
$t_{BUF}$	Bus free time		1.3			$\mu\text{s}$
$t_{HD-STA}$	Start hold time		0.6			$\mu\text{s}$
$t_{LOW}$	SCL-low hold time		1.3			$\mu\text{s}$
$t_{HIGH}$	SCL-high hold time		0.6			$\mu\text{s}$
$t_{SU-STA}$	Start setup time		0.6			$\mu\text{s}$
$t_{SU-DAT}$	Data setup time		0.1			$\mu\text{s}$
$t_r$	Rise time (SCL, SDA)				0.3	$\mu\text{s}$
$t_f$	Fall time (SCL, SDA)				0.3	$\mu\text{s}$
$t_{SU-STO}$	Stop setup time		0.6			$\mu\text{s}$



## PLL and Band Switch

 $V_{CC} = 4.5\text{ V to }5.5\text{ V}$ ,  $T_A = -20^\circ\text{C to }85^\circ\text{C}$  (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
N	Divider ratio	15-bit frequency word	512		32767	
$f_{XTAL}$	Crystal oscillator frequency	$R_{XTAL} = 25\ \Omega$ to $300\ \Omega$		4		MHz
$Z_{XTAL}$	Crystal oscillator input impedance	$V_{CC} = 5\text{ V}$ , $T_A = 25^\circ\text{C}$	1.6	2.4		k $\Omega$
$V_{XLO}$	XTALOUT output voltage	Load = $10\text{ pF}/5.1\text{ k}\Omega$ , $V_{CC} = 5\text{ V}$ , $T_A = 25^\circ\text{C}$		0.4		V <sub>p-p</sub>
$V_{VTUL}$	Tuning amplifier low-level output voltage	$R_L = 22\text{ k}\Omega$ , $VTU = 33\text{ V}$	0.2	0.3	0.46	V
$I_{VTUOFF}$	Tuning amplifier leakage current	Tuning amplifier = off, $VTU = 33\text{ V}$			10	$\mu\text{A}$
$I_{CP11}$	Charge-pump current	CP[1:0] = 11		600		$\mu\text{A}$
$I_{CP10}$		CP[1:0] = 10		350		
$I_{CP01}$		CP[1:0] = 01		140		
$I_{CP00}$		CP[1:0] = 00		70		
$V_{CP}$	Charge-pump output voltage	PLL locked		1.95		V
$I_{CPOFF}$	Charge-pump leakage current	$V_{CP} = 2\text{ V}$ , $T_A = 25^\circ\text{C}$	-15		15	nA
$I_{BS}$	Band-switch driver output current (BS1–BS4)				10	mA
$V_{BS1}$	Band-switch driver output voltage (BS1–BS4)	$I_{BS} = 10\text{ mA}$		3		V
$V_{BS2}$		$I_{BS} = 10\text{ mA}$ , $V_{CC} = 5\text{ V}$ , $T_A = 25^\circ\text{C}$		3.5	3.7	
$I_{BSOFF}$	Band-switch driver leakage current (BS1–BS4)	$V_{BS} = 0\text{ V}$			8	$\mu\text{A}$
$I_{P5}$	Band-switch port sink current (P5/ADC)				-5	mA
$V_{P5ON}$	Band-switch port output voltage (P5/ADC)	$I_{P5} = -2\text{ mA}$ , $V_{CC} = 5\text{ V}$ , $T_A = 25^\circ\text{C}$			0.6	V

## RF AGC

 $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ , measured in [Figure 24](#) reference measurement circuit at 50- $\Omega$  system, IF = 44 MHz, IF filter characteristics:  $f_{peak} = 44\text{ MHz}$  (unless otherwise noted)

PARAMETER		TEST CONDITIONS	TYP	UNIT
$I_{OAGC0}$	RF AGC output source current	ATC = 0	300	nA
$I_{OAGC1}$		ATC = 1	15	$\mu\text{A}$
$I_{OAGCSINK}$	RF AGC peak sink current	ATC = 0	100	$\mu\text{A}$
$V_{AGCSP00}$	Start-point IF output level <sup>(1)</sup>	T1/ATSS = 0, ATP[2:0] = 000	117	dB $\mu\text{V}$
$V_{AGCSP01}$		T1/ATSS = 0, ATP[2:0] = 001	114	
$V_{AGCSP02}$		T1/ATSS = 0, ATP[2:0] = 010	111	
$V_{AGCSP03}$		T1/ATSS = 0, ATP[2:0] = 011	108	
$V_{AGCSP04}$		T1/ATSS = 0, ATP[2:0] = 100	105	
$V_{AGCSP05}$		T1/ATSS = 0, ATP[2:0] = 101	102	
$V_{AGCSP06}$		T1/ATSS = 0, ATP[2:0] = 110	99	
$V_{AGCSP10}$		T1/ATSS = 1, ATP[2:0] = 000	112	
$V_{AGCSP11}$		T1/ATSS = 1, ATP[2:0] = 001	109	
$V_{AGCSP12}$		T1/ATSS = 1, ATP[2:0] = 010	106	
$V_{AGCSP13}$		T1/ATSS = 1, ATP[2:0] = 011	103	
$V_{AGCSP14}$		T1/ATSS = 1, ATP[2:0] = 100	100	
$V_{AGCSP15}$		T1/ATSS = 1, ATP[2:0] = 101	97	
$V_{AGCSP16}$		T1/ATSS = 1, ATP[2:0] = 110	94	

(1) When AISL = 1, RF AGC function is not available at VHF-L band.

## Mixer, Oscillator, IF Amplifier

$V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ , measured in Figure 24 reference measurement circuit at 50- $\Omega$  system, IF = 44 MHz, IF filter characteristics:  $f_{\text{peak}} = 44\text{ MHz}$  (unless otherwise noted)

PARAMETER		TEST CONDITIONS	TYP	UNIT
$G_{c1}$	Conversion gain (mixer-IF amplifier), VHF-L	$f_{\text{in}} = 57\text{ MHz}^{(1)}$	35	dB
$G_{c3}$		$f_{\text{in}} = 171\text{ MHz}^{(1)}$	35	
$G_{c4}$	Conversion gain (mixer-IF amplifier), VHF-H	$f_{\text{in}} = 177\text{ MHz}^{(1)}$	35	dB
$G_{c6}$		$f_{\text{in}} = 467\text{ MHz}^{(1)}$	35	
$G_{c7}$	Conversion gain (mixer-IF amplifier), UHF	$f_{\text{in}} = 473\text{ MHz}^{(1)}$	35	dB
$G_{c9}$		$f_{\text{in}} = 864\text{ MHz}^{(1)}$	35	
$NF_1$	Noise figure, VHF-L	$f_{\text{in}} = 57\text{ MHz}$	9	dB
$NF_3$		$f_{\text{in}} = 171\text{ MHz}$	9	
$NF_4$	Noise figure, VHF-H	$f_{\text{in}} = 177\text{ MHz}$	9	dB
$NF_6$		$f_{\text{in}} = 467\text{ MHz}$	9	
$NF_7$	Noise figure, UHF	$f_{\text{in}} = 473\text{ MHz}$	12	dB
$NF_9$		$f_{\text{in}} = 864\text{ MHz}$	12	
$CM_1$	Input voltage causing 1% cross-modulation distortion, VHF-L	$f_{\text{in}} = 57\text{ MHz}^{(2)}$	79	dB $\mu$ V
$CM_3$		$f_{\text{in}} = 171\text{ MHz}^{(2)}$	79	
$CM_4$	Input voltage causing 1% cross-modulation distortion, VHF-H	$f_{\text{in}} = 177\text{ MHz}^{(2)}$	79	dB $\mu$ V
$CM_6$		$f_{\text{in}} = 467\text{ MHz}^{(2)}$	79	
$CM_7$	Input voltage causing 1% cross-modulation distortion, UHF	$f_{\text{in}} = 473\text{ MHz}^{(2)}$	77	dB $\mu$ V
$CM_9$		$f_{\text{in}} = 864\text{ MHz}^{(2)}$	77	
$V_{\text{IFO1}}$	IF output voltage, VHF-L	$f_{\text{in}} = 57\text{ MHz}$	117	dB $\mu$ V
$V_{\text{IFO3}}$		$f_{\text{in}} = 171\text{ MHz}$	117	
$V_{\text{IFO4}}$	IF output voltage, VHF-H	$f_{\text{in}} = 177\text{ MHz}$	117	dB $\mu$ V
$V_{\text{IFO6}}$		$f_{\text{in}} = 467\text{ MHz}$	117	
$V_{\text{IFO7}}$	IF output voltage, UHF	$f_{\text{in}} = 473\text{ MHz}$	117	dB $\mu$ V
$V_{\text{IFO9}}$		$f_{\text{in}} = 864\text{ MHz}$	117	
$\Phi_{\text{PLVL11}}$	Phase noise, VHF-L	$f_{\text{in}} = 57\text{ MHz}$ , Offset = 1 kHz <sup>(3)</sup>	-90	dBc/Hz
$\Phi_{\text{PLVL12}}$		$f_{\text{in}} = 57\text{ MHz}$ , Offset = 10 kHz <sup>(4)</sup>	-95	
$\Phi_{\text{PLVL31}}$		$f_{\text{in}} = 171\text{ MHz}$ , Offset = 1 kHz <sup>(5)</sup>	-85	
$\Phi_{\text{PLVL32}}$		$f_{\text{in}} = 171\text{ MHz}$ , Offset = 10 kHz <sup>(4)</sup>	-95	
$\Phi_{\text{PLVL41}}$	Phase noise, VHF-H	$f_{\text{in}} = 177\text{ MHz}$ , Offset = 1 kHz <sup>(3)</sup>	-85	dBc/Hz
$\Phi_{\text{PLVL42}}$		$f_{\text{in}} = 177\text{ MHz}$ , Offset = 10 kHz <sup>(4)</sup>	-90	
$\Phi_{\text{PLVL61}}$		$f_{\text{in}} = 467\text{ MHz}$ , Offset = 1 kHz <sup>(5)</sup>	-77	
$\Phi_{\text{PLVL62}}$		$f_{\text{in}} = 467\text{ MHz}$ , Offset = 10 kHz <sup>(4)</sup>	-90	
$\Phi_{\text{PLVL71}}$	Phase noise, UHF	$f_{\text{in}} = 473\text{ MHz}$ , Offset = 1 kHz <sup>(3)</sup>	-80	dBc/Hz
$\Phi_{\text{PLVL72}}$		$f_{\text{in}} = 473\text{ MHz}$ , Offset = 10 kHz <sup>(4)</sup>	-85	
$\Phi_{\text{PLVL91}}$		$f_{\text{in}} = 864\text{ MHz}$ , Offset = 1 kHz <sup>(5)</sup>	-77	
$\Phi_{\text{PLVL92}}$		$f_{\text{in}} = 864\text{ MHz}$ , Offset = 10 kHz <sup>(4)</sup>	-90	

- (1) IF = 44 MHz, RF input level = 70 dB $\mu$ V, differential output  
(2)  $f_{\text{undes}} = f_{\text{des}} \pm 6\text{ MHz}$ ,  $P_{\text{in}} = 70\text{ dB}\mu\text{V}$ , AM 1 kHz, 30%, DES/CM = S/I = 46 dB  
(3) CP[1:0] = 10 (CP current 350  $\mu$ A), RS[2:0] = 011 (reference divider 64)  
(4) CP[1:0] = 00 (CP current 70  $\mu$ A), RS[2:0] = 100 (reference divider 128)  
(5) CP[1:0] = 11 (CP current 600  $\mu$ A), RS[2:0] = 011 (reference divider 64)

## IF Gain Controlled Amplifier

$V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ , measured in [Figure 24](#) reference measurement circuit at 50- $\Omega$  system,  $IF = 44\text{ MHz}$   
(unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$I_{IFGCA}$	Input current (IF GCA CTRL)	$V_{IFGCA} = 3\text{ V}$		30	60	$\mu\text{A}$
$V_{IFGCAMAX}$	Maximum gain control voltage	Gain maximum	2.5		$V_{CC}$	V
$V_{IFGCAMIN}$	Minimum gain control voltage	Gain minimum	0		0.4	V
$G_{IFGCAMAX}$	Maximum gain	$V_{IFGCA} = 3\text{ V}$	49	53	57	dB
$G_{IFGCAMIN}$	Minimum gain	$V_{IFGCA} = 0\text{ V}$	-4	-1	2	dB
$GCR_{IFGCA}$	Gain control range	$V_{IFGCA} = 0\text{ V to }3\text{ V}$		54		dB
$V_{IFGCAOUT}$	Output voltage	Single-ended output		2.1		Vp-p
$NF_{IFGCA}$	Noise figure	$V_{IFGCA} = 3\text{ V}$		8.5		dB
$IM3_{IFGCA}$	Third order intermodulation distortion	$f_{IFGCAIN1} = 43\text{ MHz}$ , $f_{IFGCAIN2} = 44\text{ MHz}$ , $V_{IFGCAOUT} = -2\text{ dBm}$ , $V_{IFGCA} = 3\text{ V}$		-50		dBc
$IIP3_{IFGCA}$	Input intercept point	$V_{IFGCA} = 0\text{ V}$		11		dBm
$R_{IFGCAIN}$	Input resistance (IF GCA IN1, IF GCA IN2)			1		k $\Omega$
$R_{IFGCAOUT}$	Output resistance (IF GCA OUT1, IF GCA OUT2)			19		$\Omega$

## FUNCTIONAL DESCRIPTION

### I<sup>2</sup>C Bus Mode

#### I<sup>2</sup>C Write Mode (R/W = 0)

**Table 1. Write Data Format**

	MSB						LSB			(1)
Address byte (ADB)	1	1	0	0	0	MA1	MA0	R/W = 0	A	
Divider byte 1 (DB1)	0	N14	N13	N12	N11	N10	N9	N8	A	
Divider byte 2 (DB2)	N7	N6	N5	N4	N3	N2	N1	N0	A	
Control byte 1 (CB1)	1	0	ATP2	ATP1	ATP0	RS2	RS1	RS0	A	
Band-switch byte (BB)	CP1	CP0	AISL	P5	BS4	BS3	BS2	BS1	A	
Control byte 2 (CB2)	1	1	ATC	STBY	T3	T2	T1/ATSS	T0/XLO	A	

(1) A: Acknowledge

**Table 2. Write Data Symbol Description**

SYMBOL	DESCRIPTION	DEFAULT													
MA[1:0]	Address-set bits (see <a href="#">Table 3</a> )														
N[14:0]	Programmable counter set bits $N = N14 \times 2^{14} + N13 \times 2^{13} + \dots + N1 \times 2 + N0$	N14 = N13 = N12 = ... = N0 = 0													
ATP[2:0]	RF AGC start-point control bits (see <a href="#">Table 4</a> )	ATP[2:0] = 011													
RS[2:0]	Reference divider ratio-selection bits (see <a href="#">Table 5</a> )	RS[2:0] = 111													
CP[1:0]	Charge-pump current-set bit (see <a href="#">Table 6</a> )	CP[1:0] = 11													
AISL	RF AGC detector input selection bit AISL = 0: IF amplifier AISL = 1: Mixer output	AISL = 0													
P5	Port output/ADC input control bit P5 = 0: ADC INPUT P5 = 1: Tr = ON	P5 = 0													
BS[4:1]	Band-switch control bits BSn = 0: Tr = OFF BSn = 1: Tr = ON	BSn = 0													
	Band selection by BS[1:2] <table border="1"> <thead> <tr> <th>BS1</th> <th>BS2</th> <th></th> </tr> </thead> <tbody> <tr> <td>1</td> <td>0</td> <td>VHF-LO</td> </tr> <tr> <td>0</td> <td>1</td> <td>VHF-HI</td> </tr> <tr> <td>0</td> <td>0</td> <td>UHF</td> </tr> <tr> <td>1</td> <td>1</td> <td>Reserved</td> </tr> </tbody> </table>		BS1	BS2		1	0	VHF-LO	0	1	VHF-HI	0	0	UHF	1
BS1	BS2														
1	0	VHF-LO													
0	1	VHF-HI													
0	0	UHF													
1	1	Reserved													
ATC	RF AGC current-set bit ATC = 0: Current = 300 nA ATC = 1: Current = 15 μA	ATC = 0													
STBY	Power standby mode-control bit STBY = 0: Normal operation STBY = 1: Standby mode/stop MOP function (XTALOUT is available even in standby mode)	STBY = 0													
T3, T2, T1/ATSS, T0/XLO	TEST bits, RFAGC shift bit, XTALOUT control bit (see <a href="#">Table 7</a> )	T[3:0] = 0010													
X	Don't care														

**Table 3. Address Selection**

MA1	MA0	VOLTAGE APPLIED ON AS INPUT
0	0	0 V to 0.1 V <sub>CC</sub> (Low)
0	1	OPEN, or 0.2 V <sub>CC</sub> to 0.3 V <sub>CC</sub> (Mid2)
1	0	0.4 V <sub>CC</sub> to 0.6 V <sub>CC</sub> (Mid1)
1	1	0.9 V <sub>CC</sub> to V <sub>CC</sub> (High)

**Table 4. RF AGC Start Point<sup>(1)</sup>**

T1/ATSS	ATP2	ATP1	ATP0	IFOUT LEVEL (dBμV)
0	0	0	0	117
0	0	0	1	114
0	0	1	0	111
0	0	1	1	108
0	1	0	0	105
0	1	0	1	102
0	1	1	0	99
0	1	1	1	Disabled
1	0	0	0	112
1	0	0	1	109
1	0	1	0	106
1	0	1	1	103
1	1	0	0	100
1	1	0	1	97
1	1	1	0	94
1	1	1	1	Disabled

(1) When AISL = 1, RF AGC function is not available at VHF-L band (output level is undefined).

**Table 5. Reference Divider Ratio**

RS2	RS1	RS0	REFERENCE DIVIDER RATIO
0	0	0	24
0	0	1	28
0	1	0	50
0	1	1	64
1	0	0	128
1	X	1	80

**Table 6. Charge-Pump Current**

CP1	CP0	CHARGE PUMP CURRENT (μA)
0	0	70
0	1	140
1	0	350
1	1	600

**Table 7. Test Bits/XTALOUT Control** <sup>(1)</sup>

T3	T2	T1/ATSS	T0/XLO	DEVICE OPERATION	XTALOUT 4-MHz OUTPUT
0	0	X	0	Normal operation	Enabled
0	0	X	1	Normal operation	Disabled
X	1	X	X	Test mode	Not available
1	X	X	X	Test mode	Not available

(1) RFAGC and XTALOUT are not available in test mode.

### Example I<sup>2</sup>C Data Write Sequences

Telegram examples:

Start-ADB-DB1-DB2-CB1-BB-CB2-Stop  
 Start-ADB-DB1-DB2-Stop  
 Start-ADB-CB1-BB-CB2-Stop  
 Start-ADB-CB1-BB-Stop  
 Start-ADB-CB2-Stop

Abbreviations:

ADB: Address byte  
 BB: Band-switch byte  
 CB1: Control byte 1  
 CB2: Control byte 2  
 DB1: Divider byte 1  
 DB2: Divider byte 2  
 Start: Start condition  
 Stop: Stop condition

### I<sup>2</sup>C Read Mode ( $R/\overline{W} = 1$ )

**Table 8. Read Data Format (A: Acknowledge)**

	MSB							LSB	
Address byte (ADB)	1	1	0	0	0	MA1	MA0	$R/\overline{W} = 1$	A
Status byte (SB)	POR	FL	1	1	X	A2	A1	A0	–

**Table 9. Read Data Symbol Description**

SYMBOL	DESCRIPTION	DEFAULT
MA[1:0]	Address set bits (see <a href="#">Table 3</a> )	
POR	Power-on-reset flag POR set: power on POR reset: end-of-data transmission procedure	POR = 1
FL	In-lock flag PLL locked (FL = 1), unlocked (FL = 0)	
A[2:0]	Digital data of ADC (see <a href="#">Table 10</a> ) Bit P5 must be set to 0.	

Table 10. ADC Level<sup>(1)</sup>

A2	A1	A0	VOLTAGE APPLIED ON ADC INPUT
1	0	0	0.6 V <sub>CC</sub> to V <sub>CC</sub>
0	1	1	0.45 V <sub>CC</sub> to 0.6 V <sub>CC</sub>
0	1	0	0.3 V <sub>CC</sub> to 0.45 V <sub>CC</sub>
0	0	1	0.15 V <sub>CC</sub> to 0.3 V <sub>CC</sub>
0	0	0	0 V to 0.15 V <sub>CC</sub>

(1) Accuracy is  $0.03 \times V_{CC}$ .

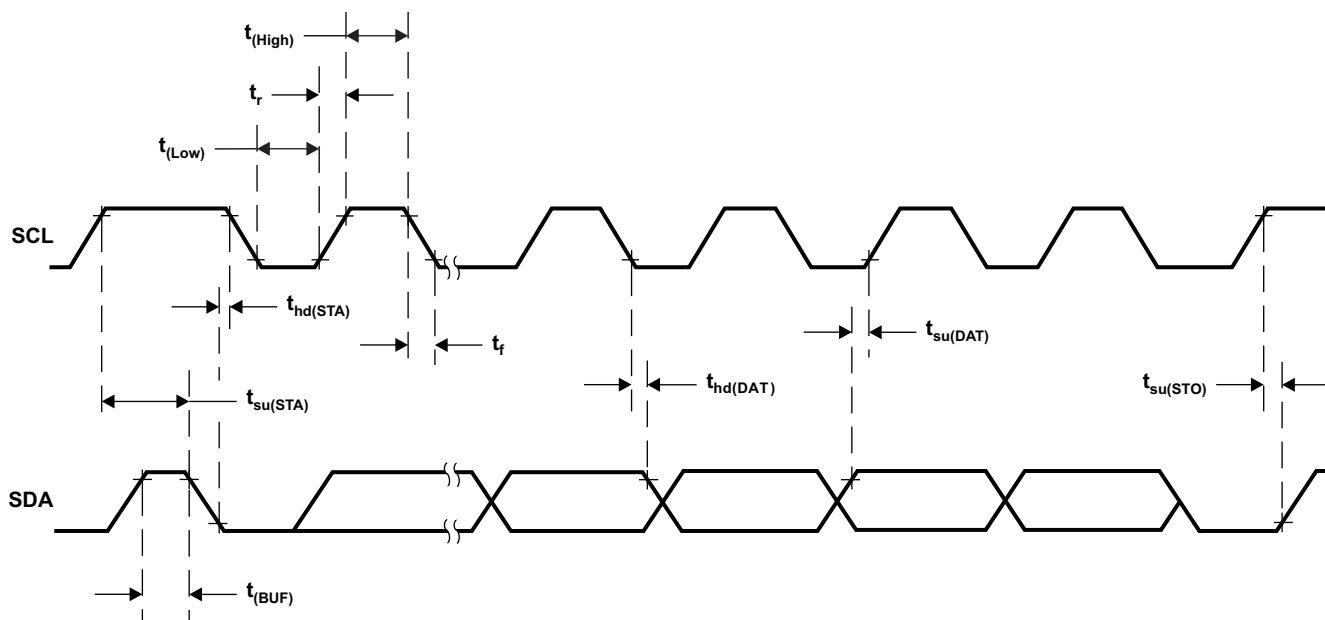
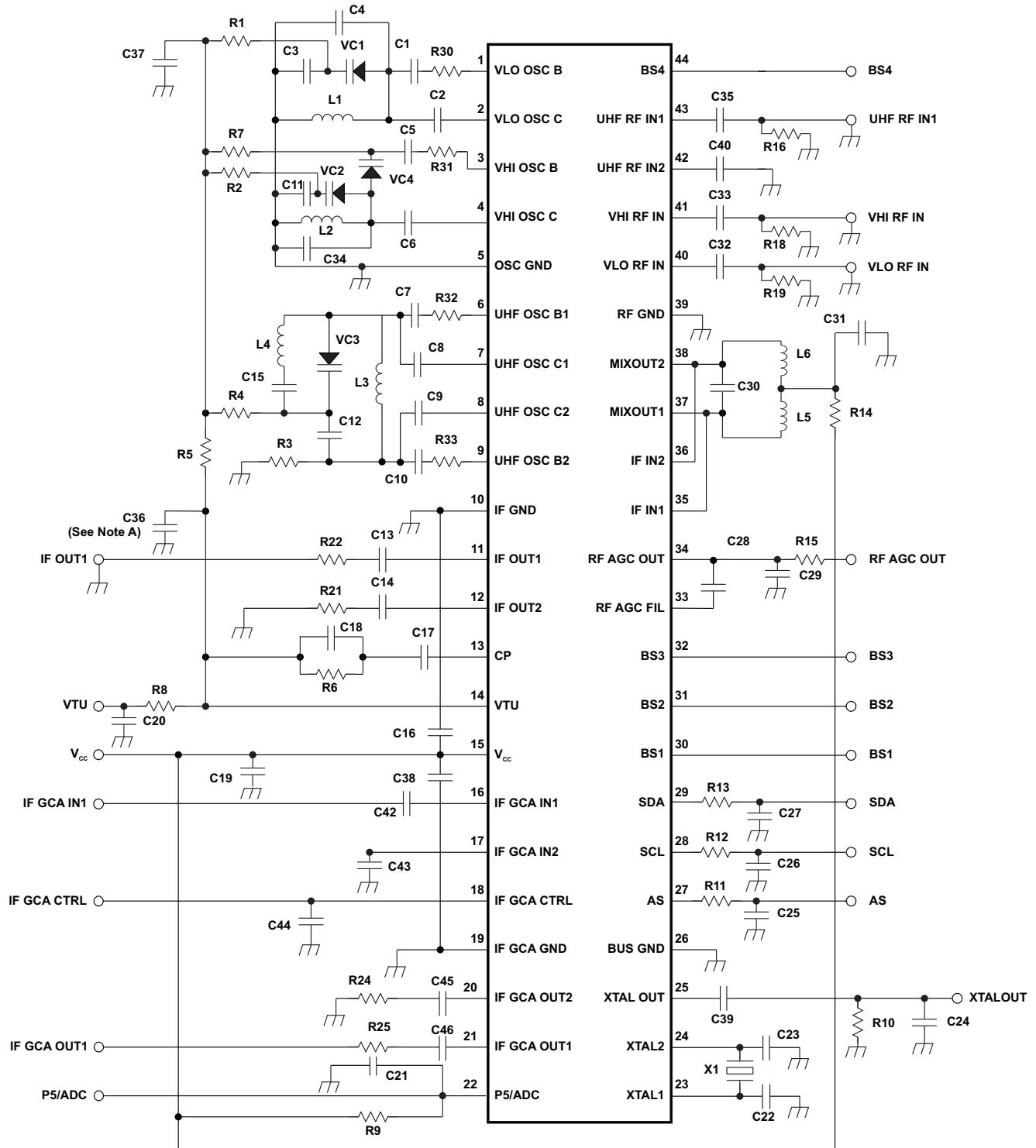


Figure 23. I<sup>2</sup>C Timing Chart

## APPLICATION INFORMATION





**Component Values for Measurement Circuit**

PART NAME	VALUE	PART NAME	VALUE
C1 (VLO OSC B)	1 pF	C43 (IF GCA IN2)	2.2 nF
C2 (VLO OSC C)	2 pF	C44 (IF GCA CTRL)	2.2 nF
C3 (VLO OSC)	47 pF	C45 (IF GCA OUT1)	2.2 nF
C4 (VLO OSC)	Open	C46 (IF GCA OUT2)	2.2 nF
C5 (VHI OSC)	7 pF	L1 (VLO OSC)	φ3,0 mm, 7T, wire 0,32 mm
C6 (VHI OSC C)	5 pF	L2 (VHI OSC)	φ2,0 mm, 3T, wire 0,4 mm
C7 (UHF OSC B1)	1.5 pF	L3 (UHF OSC)	φ1,8 mm, 3T, wire 0,4 mm
C8 (UHF OSC C1)	1 pF	L4 (UHF OSC)	φ1,8 mm, 3T, wire 0,4 mm
C9 (UHF OSC C2)	1 pF	L5 (MIXOUT)	680 nH (LK1608R68K-T)
C10 (UHF OSC B2)	1.5 pF	L6 (MIXOUT)	680 nH (LK1608R68K-T)
C11 (VHI OSC)	51 pF	R1 (VLO OSC)	3.3 kΩ
C12 (UHF OSC)	10 pF	R2 (VHI OSC)	3.3 kΩ
C13 (IF OUT)	2.2 nF	R3 (UHF OSC)	2.2 kΩ
C14 (IF OUT)	2.2 nF	R4 (UHF OSC)	1 kΩ
C15 (UHF OSC)	100 pF	R5 (VTU)	3 kΩ
C16 (V <sub>CC</sub> )	4.7 nF	R6 (CP)	47 kΩ
C17 (CP)	0.01 μF/50 V	R7 (VHI OSC)	3.3 kΩ
C18 (CP)	22 pF/50 V	R8 (VTU)	20 kΩ
C19 (V <sub>CC</sub> )	2.2 nF	R9 (P5/ADC)	Open
C20 (VTU)	2.2 nF/50 V	R10 (XTALOUT)	5.1 kΩ
C21 (P5/ADC)	Open	R11 (AS)	330 Ω
C22 (XTAL)	27 pF	R12 (SCL)	330 Ω
C23 (XTAL)	27 pF	R13 (SDA)	330 Ω
C24 (XTALOUT)	10 pF	R14 (V <sub>CC</sub> )	0
C25 (AS)	22 pF	R15 (RF AGC OUT)	0
C26 (SCL)	Open	R16 (UHF RF IN1)	(50 Ω)
C27 (SDA)	Open	R18 (VHI RF IN)	(50 Ω)
C28 (AGC FIL)	1 nF	R19 (VLO RF IN)	(50 Ω)
C29 (RF AGC OUT)	0.15 μF	R21 (IF OUT2)	1 kΩ
C30 (MIXOUT)	4 pF	R22 (IF OUT1)	1 kΩ
C31 (MIXOUT)	2.2 nF	R24 (IF GCA OUT1)	250 Ω
C32 (VLO RF IN)	2.2 nF	R25 (IF GCA OUT2)	200 Ω
C33 (VHI RF IN)	2.2 nF	R30 (VLO OSC B)	0
C34 (VHI OSC)	0.5 pF	R31 (VHI OSC B)	4.7 Ω
C35 (UHF RF IN1)	2.2 nF	R32 (UHF OSC B1)	0
C36 (VTU)	22 pF	R33 (UHF OSC B2)	0
C37 (VTU)	2.2 nF/50 V	VC1 (VLO OSC)	MA2S374
C38 (V <sub>CC</sub> )	0.1 μF	VC2 (VHI OSC)	MA2S374
C39 (XTALOUT)	2.2 nF	VC3 (UHF OSC)	MA2S372
C40 (UHF RF IN2)	2.2 nF	VC4 (VHI OSC)	MA2S372
C42 (IF GCA IN1)	2.2 nF	X1	4-MHz crystal

APPLICATION INFORMATION (CONTINUED)

Test Circuits

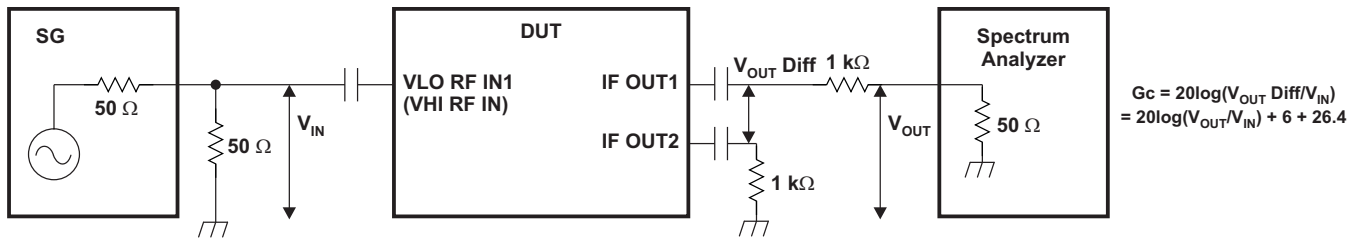


Figure 25. VHF-Conversion Gain-Measurement Circuit

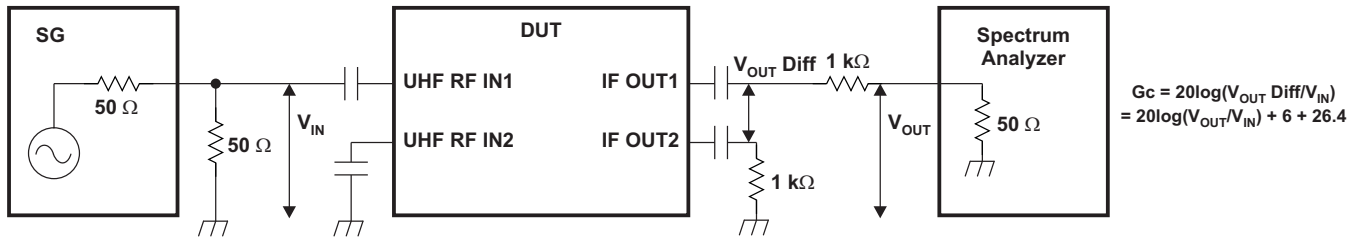


Figure 26. UHF-Conversion Gain-Measurement Circuit

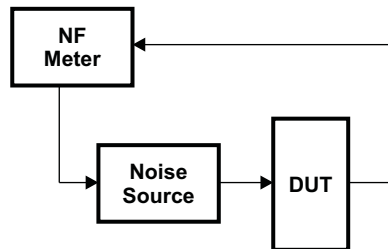


Figure 27. Noise-Figure Measurement Circuit

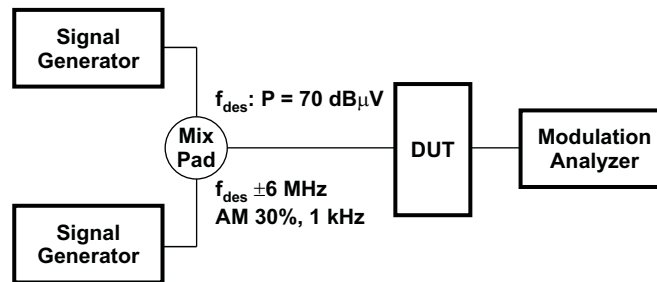


Figure 28. 1% Cross-Modulation Distortion Measurement Circuit

TYPICAL CHARACTERISTICS

Band-Switch Driver Output Voltage (BS1–BS4)

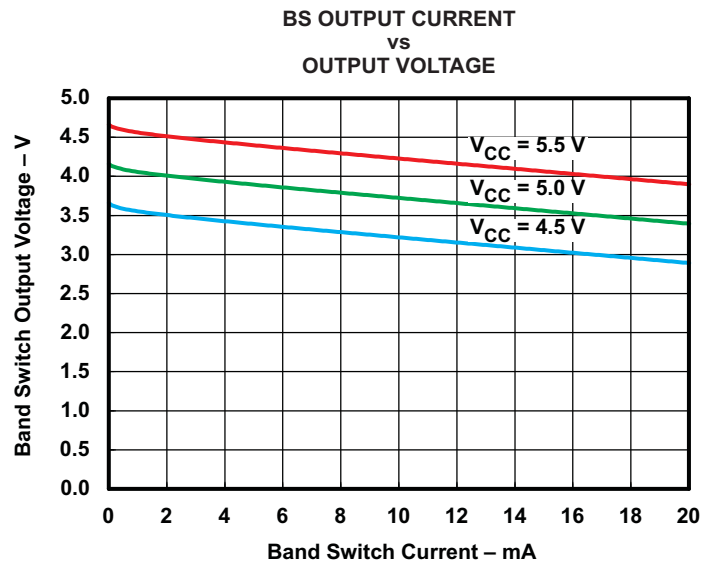


Figure 29. Band-Switch Driver Output Voltage

S-Parameter

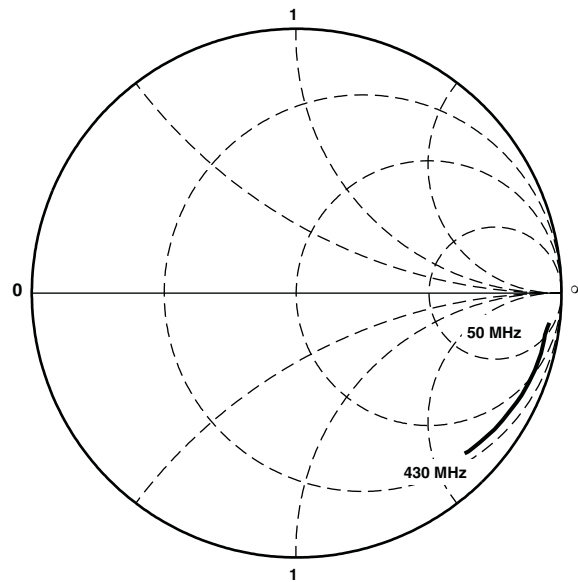


Figure 30. VLO RFIN, VHI RFIN

TYPICAL CHARACTERISTICS (continued)

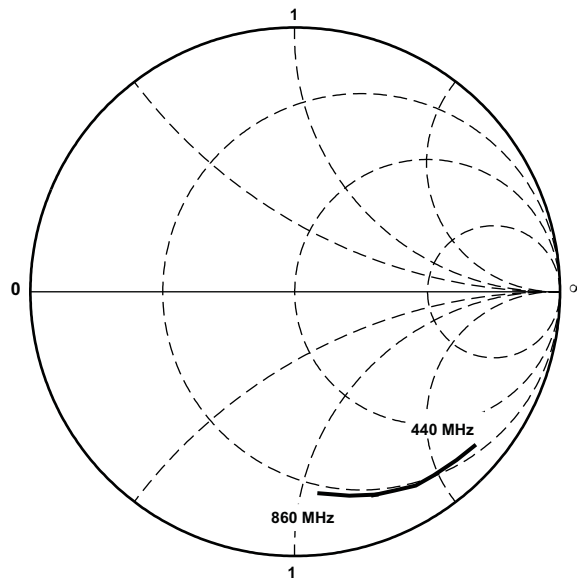


Figure 31. UHF RFIN

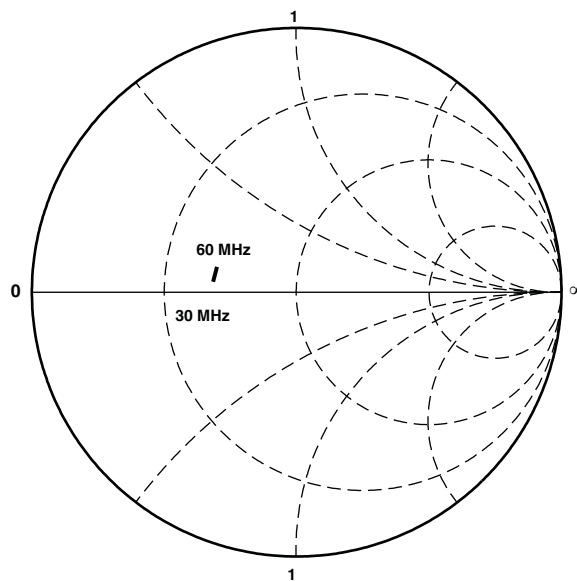


Figure 32. IFOUT

TYPICAL CHARACTERISTICS (continued)

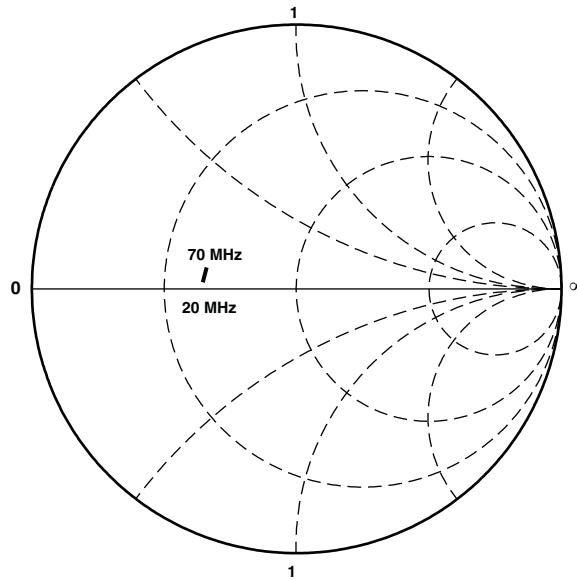


Figure 33. IF GCA OUT

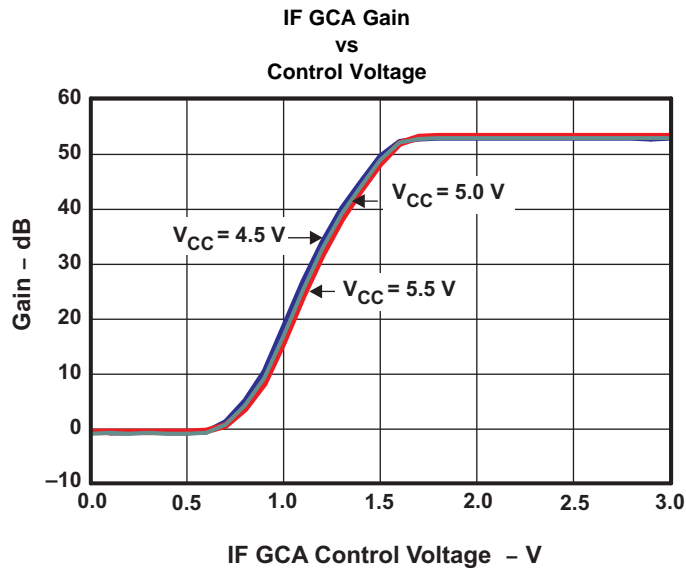


Figure 34. IF GCA Gain vs Control Voltage

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
SN761668DBTR	OBSOLETE	TSSOP	DBT	44		TBD	Call TI	Call TI	-20 to 85	SN761668	
SN761668DBTR-M	OBSOLETE	TSSOP	DBT	44		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR		SN761668	

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

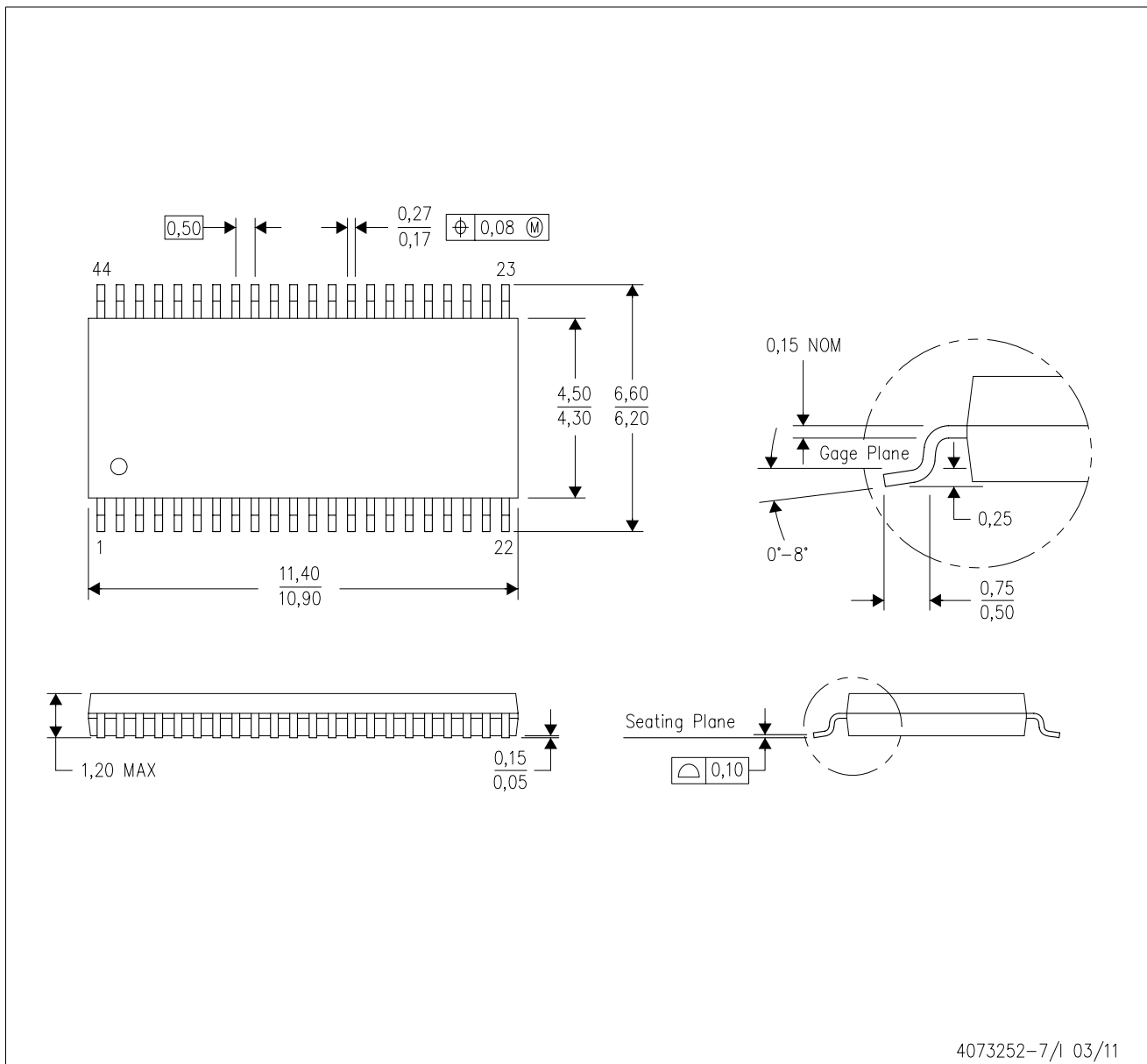
**Important Information and Disclaimer:** The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

# MECHANICAL DATA

DBT (R-PDSO-G44)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion.



## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

### Products

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
OMAP Applications Processors	<a href="http://www.ti.com/omap">www.ti.com/omap</a>
Wireless Connectivity	<a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a>

### Applications

Automotive and Transportation	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
Computers and Peripherals	<a href="http://www.ti.com/computers">www.ti.com/computers</a>
Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Energy and Lighting	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Space, Avionics and Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>

### TI E2E Community

[e2e.ti.com](http://e2e.ti.com)